

**REMARKS**

By this amendment, currently amended independent claim 6 incorporates the features of cancelled dependent claim 7. The 35 U.S.C. §102(b) rejection of claim 6 over Akram (U.S. Patent No. 5,483,741) is therefore obviated. Applicant respectfully traverses the 35 U.S.C. §103(a) rejection of cancelled claim 7 over Akram in view of Jin (U.S. Patent No. 7,112,974), which now applies to currently amended claim 6.

The Office Action alleges that Akram discloses all of the elements of amended claim 6 except for a plurality of conductive materials buried in the contact portion and made of a material harder than the contact portion. However, the Office Action relies on Jin to allegedly disclose conductive materials buried in the contract portion and made of a material harder than the contact portion.

Akram, in col. 5, lines 47-57, discloses that element 43, cited by the Examiner as allegedly corresponding to the plurality of conductive materials recited in amended claim 6, is an apex group projecting from a substrate surface formed by selectively etching the substrate. Akram further discloses that the apex group is covered in various insulating and conductive layers, e.g. in Figs. 10-14. Akram discloses a contiguous series of projections, made of the same material that they project from. In contrast, amended claim 6 recites a plurality of conductive materials, buried in the contact portion and made of a material harder than the contact portion, each of which has a tip portion which projects from the contact surface of the contact portion. Akram does not disclose or suggest such a structure, wherein the projections are formed from discrete pieces of a hard material buried in the contact portion.

Jin discloses, in Fig. 1C and column 3, line 24 through column 4, line 45, a probe with a hardening component. Jin discloses, in col. 3, lines 33-34, that the hardening component is attached to the surface of the probe by an adhesive. In contrast, amended claim 6 recites a plurality of conductive materials that are buried in the contact portion. Jin does not disclose or suggest that the hardening component is buried in the contact portion.

Jin, in col 3. lines 38-40, discloses that the hardening component may be coated with a conductive coating because it may not be electrically conductive. In contrast, amended claim 6 recites a plurality of conductive materials. The hardening component of Jin is not disclosed or suggested to be conductive. If it were intended to be conductive, it would not require a conductive coating. Even though Jin states that the conductive coating “may be deposited”, and the hardening material “may not be conductive,” Jin does not disclose any variants where the hardening material is conductive or the coating is not deposited. The only hardening material disclosed by Jin, diamond, is valued as an insulator, for having very high electrical resistivity unless it is specifically formulated not to. See, for example, MARK A. PRELAS ET AL., HANDBOOK OF INDUSTRIAL DIAMONDS AND DIAMOND FILMS, PG 1044, attached. Jin does not disclose that the hardening component is “conductive” or “doped” diamond, and therefore one of ordinary skill in the art would understand that Jin discloses only natural, non-conductive diamond.

Jin discloses a structure, shown in Fig. 1C, that is a probe coated in a layer of non-conductive hardening material, further coated in a layer of conductive coating. Jin discloses, in col. 4 lines 27-30, that the entire probe structure penetrates an oxide layer.

Therefore, each particle of the hardening component does not penetrate the oxide layer individually. In contrast, amended claim 6 recites that each of the conductive materials has a tip portion projecting from the surface, and that these separate tip portions penetrate an oxide layer. Jin does not disclose or suggest a hardening component which projects from the surface of the contact portion of the probe in order to individually penetrate an oxide layer.

In summary, Akram discloses a structure, made from a single material, having a series of projections. Jin discloses a probe with a layer of hardening material. Neither Akram nor Jin disclose or suggest a plurality of conductive materials, buried in the contact portion of a probe, made of a material harder than the contact portion, each of which has a tip portion projecting from the surface that penetrates an oxide layer, as recited in amended claim 6. Therefore, because the cited references together fail to disclose or suggest all of the elements of amended claim 6, no *prima facie* case of obviousness is established. Claim 8, which depends from claim 6, is also not obvious in view of the cited references for at least the reasons stated.

In view of the foregoing remarks, Applicant submits that the claims, as amended, are neither anticipated nor rendered obvious in view of the prior art references cited against this application. Applicant submits that the proposed amendment of claim 6 does not raise new issues or necessitate the undertaking of any additional search of the art by the Examiner, since all of the claimed elements and their claimed relationships were earlier claimed. This Amendment should allow for immediate action by the Examiner. Applicant therefore requests the entry of this Amendment, the Examiner's reconsideration of the application, and the timely allowance of the pending claims.

Finally, Applicant submits that the entry of this Amendment would place the application in better form for appeal, should the Examiner dispute the patentability of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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Dated: August 18, 2009

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# **HANDBOOK OF INDUSTRIAL DIAMONDS AND DIAMOND FILMS**

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MARCEL DEKKER, INC.

NEW YORK · BASEL · HONG KONG

**Library of Congress Cataloging-in-Publication Data**

**Handbook of industrial diamonds and diamond films / [edited by] Mark A. Prelas,  
Galina Popovici, Louis K. Bigelow.**

p. cm.

Includes index.

ISBN 0-8247-9994-1 (hardcover : alk. paper)

1. Diamonds. 2. Diamonds, Industrial. 3. Diamond thin films—Industrial applications. 4. Diamonds, Artificial—Industrial applications. I. Prelas, Mark Antonio. II. Popovici, Galina. III. Bigelow, Louis.

TA455.C3H6 1997

666'.88—dc21

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270 Madison Avenue, New York, New York 10016  
<http://www.dekker.com>

Current printing (last digit):  
10 9 8 7 6 5 4 3 2 1

**PRINTED IN THE UNITED STATES OF AMERICA**

Table I. Electrical Properties of Diamond at room temperature.

Property	298 K	Units	Property	298 K	Units
thermal conductivity	20	W/cm·K	band gap	5.45	eV
thermal expansion	$1.1 \cdot 10^{-6}$	K <sup>-1</sup>	undoped resistivity	$>10^{15}$	Ω·cm
electric breakdown field	10	MV/cm	dielectric constant	5.7	
saturated current velocity			mobility		
electron	$2.7 \cdot 10^7$	cm/s	electron	2200	cm <sup>2</sup> /V·s
hole	$1.0 \cdot 10^7$	cm/s	hole	2000	cm <sup>2</sup> /V·s

electronics devices and to identify areas that require additional development in order for diamond to achieve its potential.

## 2. Device Quality Diamond

For active electronic devices it is desirable to have i) insulating regions, ii) p and n-type semiconducting material and iii) Ohmic, Schottky or insulating contacts. Diamond's wide band gap allows undoped diamond to be a good insulator while doped diamond is used for the semiconducting regions. The ability to serve as both the insulator and the semiconductor make diamond a versatile material for active electronic devices. Additionally, through the use of various contact metallurgy, both Ohmic and Schottky contacts can be made to diamond. Various insulators can be used to form capacitive structures for field-effect devices.

### 2.1 INSULATING DIAMOND

The observed resistivity of high quality undoped diamond exceeds  $10^{15}$ - $10^{16}$  Ω·cm at room temperature. [Vandersande 1995] This resistivity limit is "apparatus-limited" due to leakage currents within the measurement setup. To characterize the resistivity of diamond, variable temperature resistivity measurements up to 1000-1200°C have been performed on both chemical vapor deposited (CVD) and natural diamond, as shown in Figure 1. [Vandersande 1995] In this figure, the conductivity, or reciprocal of the resistivity, is shown as a function of reciprocal temperature. The resistivity of the Crystallume 2 and Raytheon films exceeds the resistance of the natural diamond by about 100x at 1000°C and demonstrates the ability to fabricate high quality undoped CVD diamond.

From the temperature dependence of the resistivity, the observed activation energy is 1.6 eV. If this activation energy is used, the extrapolated room temperature resistivity is  $\sim 10^{27}$  Ω·cm. Using the band gap energy of 5.45 eV, the theoretical room temperature resistivity for intrinsic diamond is  $>10^{42}$  Ω·cm. The difference between the observed and theoretical activation energy and the difference in room temperature resistivity estimates indicate that intrinsic conduction does not dominate for insulating diamond. Based on the similarity of the activation energy and the energy transition of isolated substitutional nitrogen, this species has been proposed to be responsible for the conduction in insulating diamond. [Vandersande 1995]

Figure 1

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